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Using Passive Sonar for Swimmer Localization: A Feasibility Study

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NEWPORT

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USING PASSIVE SONAR FOR SWIMMER LOCALIZATION: A FEASIBILITY STUDY

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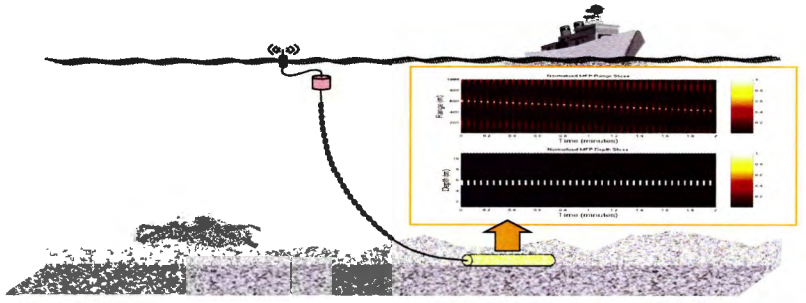

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Introduction

- **Objective:** Assess the feasibility of applying passive sonar processing techniques to the detection and localization of scuba swimmers

- **Proposed Solution:** Apply matched-field processing and adaptive interference suppression techniques for the localization (range & depth) of swimmers using vertical array(s)

- **Advantages of Passive over Active Processing Include:**

1. Passive processing provides covert detection

2. Active processing known to have difficulty in detecting swimmer near water's surface

3. Passive Processing avoids negative environmental issues associated with active acoustic energy transmissions

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Approach

➢ **Objective of feasibility study is to answer the question:**

Does a scuba swimmer emit signals of a sufficient level to be detectable at tactically useful ranges in a harbor environment?

If yes, then matched-field processing which exploits multipath propagation should be a viable solution

➢ **Approach:**

1. Determine radiated pressure spectrum level (PSL) and frequency signature of diver inhale breaths from experimental data

2. Use PSL in conjunction with a very shallow water propagation model to estimate maximum detection range of swimmers

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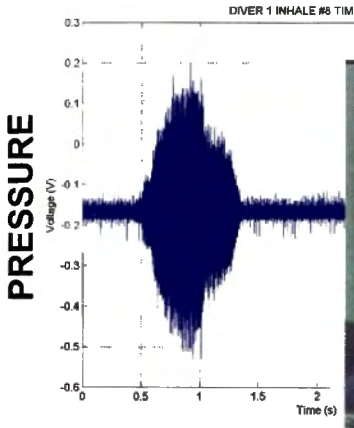
Measuring Diver Radiated Signal Power



PRESSURE

TIME

Courtesy Roy Manstan and NUWC Dive Team

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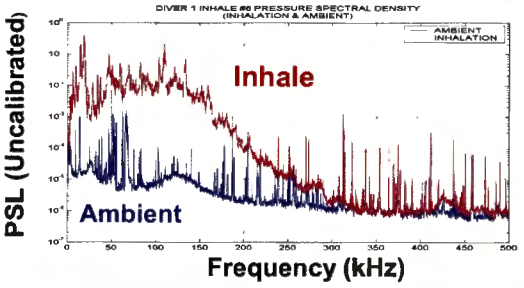
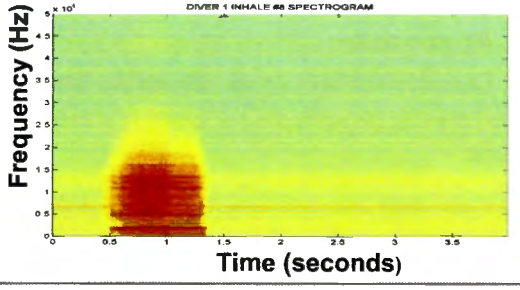
Swimmer Acoustic Measurements

- Swimmer suspended motionless in acoustic tank
- Hydrophone nearby collected radiated noise from scuba gear
- Inhale breaths provide highest signal levels
- Inhale breaths produces broadband frequency signature





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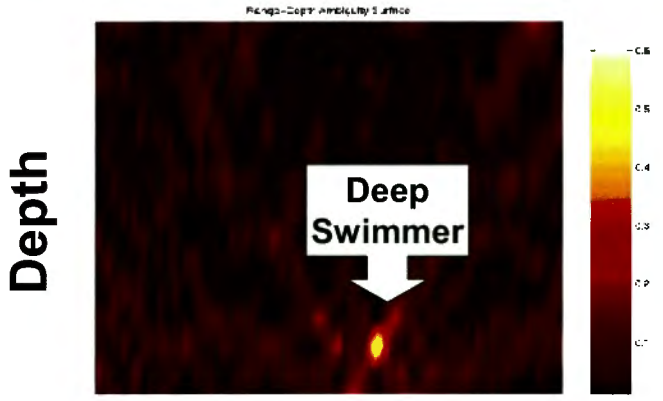
Hot Spot at Depth and Range where (Deep) Swimmer is present



Depth

Range

With the "right stuff" (sensors and processing) swimmers are detectable

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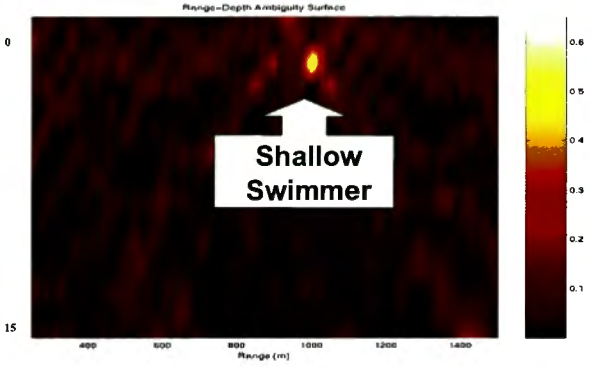
Hot Spot at Depth and Range where (Shallow) Swimmer is present



Depth

Range

With the "right stuff" (sensors and processing) swimmers are detectable, even at shallow depths where active fails

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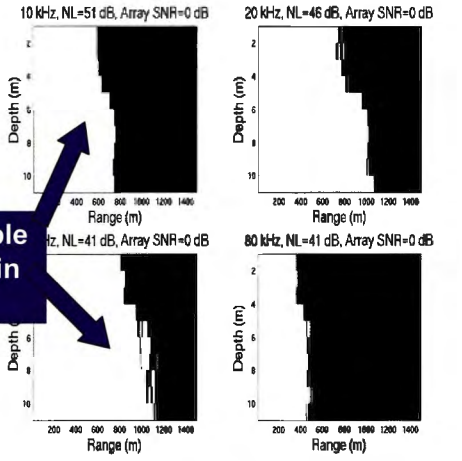
Detection Region Estimates

- Use normal mode propagation model to model multipath in very shallow-water harbor channels (i.e., 10 – 15 meters)
- Use calibrated PSL measurements and transmission loss computed from model to estimate detection regions of swimmers in range-depth space
- Assumptions:
  1. Vertical spanning array with 22 equally spaced sensors
  2. SVP measured in Narragansett Bay*
  3. Sea state 1 (plus 15 dB)
  4. SNR of 0 dB required at array for localization
- Results suggest swimmers detectable to ranges beyond 500 m



Range vs. Depth for 4 Frequencies

*SVP Data provided by R. Manstan, NUWC

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Conclusions

- Preliminary analysis using experimental swimmer PSL suggests swimmers detectable to ranges beyond 500 m
- Matched-field processing (MFP) should provide a viable solution to swimmer localization
- MFP software for swimmer localization developed and validated using simulated swimmer data
- Further analysis recommended using swimmer data collected in wide variety of harbor environments to calibrate performance of Detection, Classification & Localization (DCL)

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